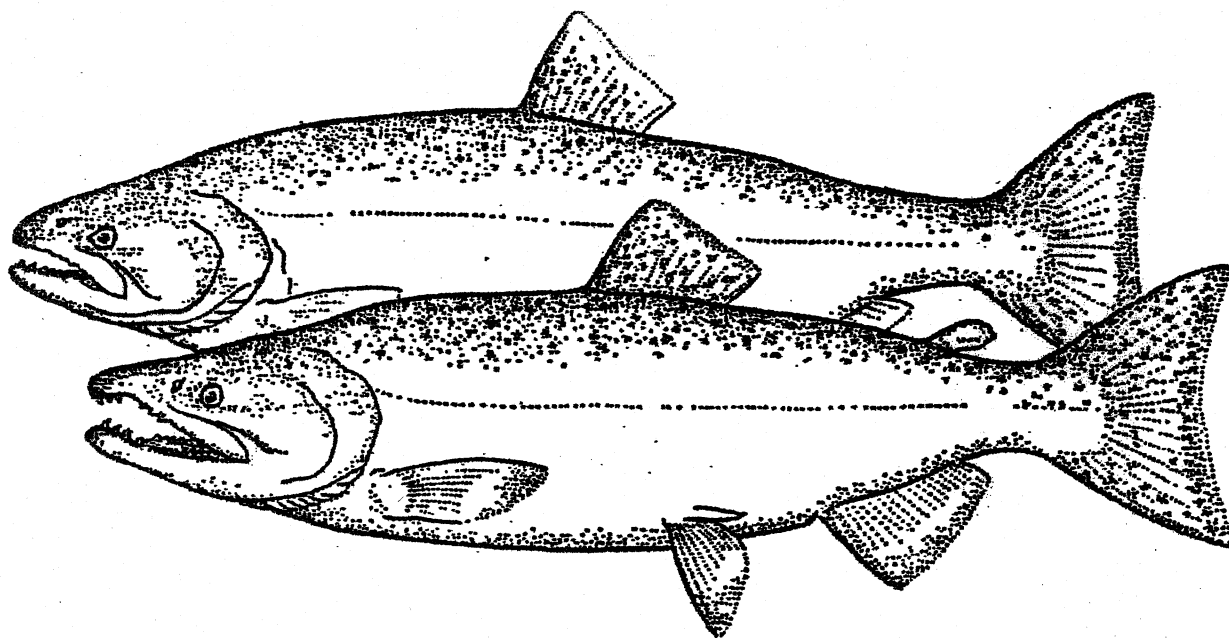


JUNE 2004

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**SPRING AND SUMMER CHINOOK SALMON  
SPAWNING GROUND SURVEYS  
ON THE ENTIAT RIVER, 2003**



Fish and Wildlife Service

U.S. Department of the Interior

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**Spring and Summer Chinook Salmon  
Spawning Ground Surveys on the Entiat River, 2003**

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## INTRODUCTION

From 1962 to 1994, spring Chinook salmon, *Oncorhynchus tshawytscha*, spawning was monitored by the Washington Department of Fish and Wildlife (WDFW) in a seven-mile section of the Entiat River known as the "index area" (river mile 28.9 to 21.3). From 1957 to 1991, the Chelan County Public Utility District monitored summer Chinook salmon spawning in the lower ten miles (river mile 0 to 10.4) of the Entiat River. While informative, these monitoring efforts were later believed to be either deficient in scope (area surveyed) and/or methodology. In 1994, in recognition of the need to improve the spawning survey efforts, the United States Fish and Wildlife Service (USFWS), Mid-Columbia River Fishery Resource Office (MCRFRO), began a program of monitoring spring and summer Chinook salmon spawning more intensely on the Entiat River. Efforts in 2003 mark the tenth year that MCRFRO has conducted the expanded spawning surveys.

The objectives of the spawning surveys are to:

1. Continue to assess the distribution of spring and summer Chinook salmon spawning throughout the index and expanded area of the Entiat & Mad Rivers and provide accurate estimates of the respective spawning populations.
2. Analyze population trend data for spring and summer Chinook salmon in the Entiat River.
3. Evaluate possible straying of hatchery spring and summer Chinook salmon.
4. Search for and note presence and/or redds of other salmonid species, which may include sockeye salmon, *O. nerka*, coho salmon, *O. kisutch*, Pacific lamprey, *Entosphenus tridentatus* and bull trout, *Salvelinus confluentus* and identify their spawning distribution in the survey sections.

## STUDY AREA

The Entiat River Basin is located in Chelan County, north-central Washington State. The river heads in a glaciated basin near the crest of the Cascade Mountains and flows southeasterly. Base flow is 385 cubic feet per second (Mullan et al. 1992) and major tributaries are the North Fork (river mile 34) and Mad River (river mile 10.5). The upstream limit of anadromy is Entiat Falls (river mile 33.8).

The Entiat system drains an area of about 416.5 square miles. The watershed is nearly 42 miles in length and varies in width from 5 to 14 miles. The basin's highest elevation is the 9,249 foot summit of Mt. Fernow and its lowest is about 700 feet at the confluence with the Columbia River (USDA 1979). The Entiat River enters the Columbia River at approximately river mile 484, eight mainstem hydroelectric dams above the Pacific Ocean.

Spring Chinook salmon spawning ground surveys were conducted between Fox Creek Campground and McKenzie Diversion Dam (river mile 28.1 to 16.2), and Mad River (river mile 5.2 to 1.5) (Figure 1). Summer Chinook salmon surveys focused on Reaches 1 through 5 (river mile 28.1 to 16.2), Roaring Creek Bridge just below Entiat NFH (river mile 6.7), and from Dinkleman Canyon Road to the Columbia River influence (river mile 4.1 to 0.3) (Figure 1).

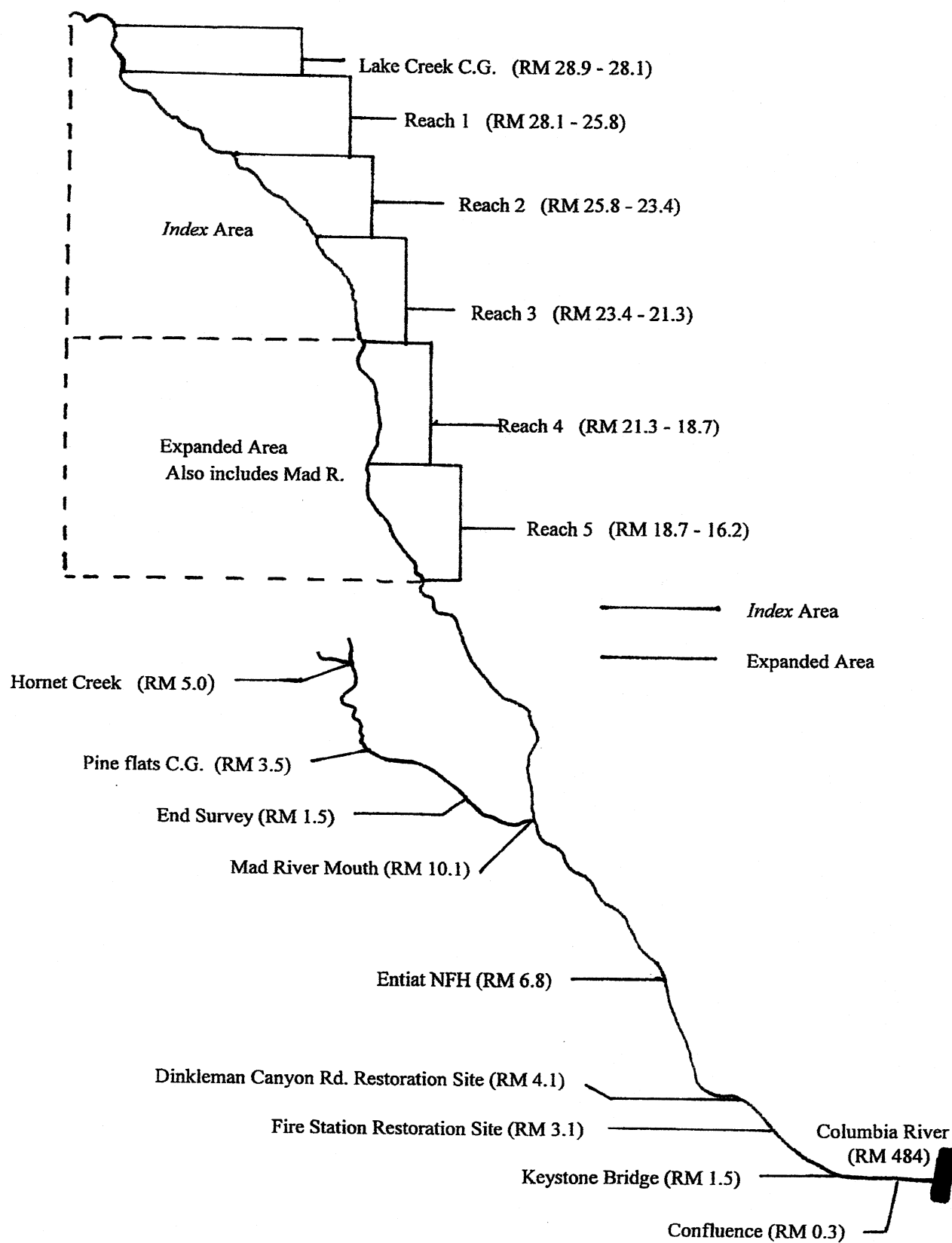


Figure 1. Overview of the Entiat River spawning ground survey areas.

## **SALMON POPULATIONS**

The Entiat River historically supported excellent salmon runs consisting of Chinook (probably spring Chinook salmon) and coho salmon (Craig and Suomela 1941). Construction of dams around the turn of the century near the mouth of the Entiat River blocked salmon from their spawning grounds, and salmon runs were essentially nonexistent by 1939 when Grand Coulee Dam was built (Craig and Suomela 1941). From 1939 to 1943, as part of the Grand Coulee Fish Maintenance Project mitigation effort, all ascending adult salmon (mainly summer and fall Chinook salmon) were trapped at Rock Island Dam and relocated to upstream tributary streams below Grand Coulee Dam, including the Entiat River, and to hatcheries, including Leavenworth, Entiat, and Winthrop National Fish Hatcheries (NFH) (Fish and Hanavan 1948). The goal of these efforts was to rebuild salmon runs in the tributary streams and mitigate for lost production above Grand Coulee Dam.

### **Spring Chinook Salmon**

In the initial years after Grand Coulee Dam was built, little effort was made to re-establish wild spring Chinook salmon runs in the Entiat River. From 1942 to 1944, Entiat NFH released a total of 1.3 million sub-yearling and fewer than 50,000 yearling spring Chinook salmon that were offspring of the upriver stocks collected at Rock Island Dam (Mullan 1987). No spring Chinook salmon were released from Entiat NFH from 1945 to 1975. As early as 1956 and 1957, a wild spring Chinook salmon run was observed spawning in the area above Stormy Creek (river mile 18.4) (French and Wahle 1960). Since 1962, spring Chinook salmon redds have been counted in an *index* area between river mile 28 and 21, where an established spring Chinook salmon run had been documented. Entiat NFH resumed spring Chinook salmon production in 1974. Egg sources have included Cowlitz River (1974), Carson NFH (1975 to 1982), Little White Salmon NFH (1976, 1978, 1979, 1981), Leavenworth NFH (1979-1981, 1994), and Winthrop NFH (1988). Adults that voluntarily returned to the hatchery were the primary brood stock in 1980 and from 1983 to the present.

### **Summer Chinook Salmon**

Although summer Chinook salmon are not believed to be endemic to the Entiat River (Craig and Suomela 1941), several efforts were made to establish summer Chinook in the Entiat River following completion of Grand Coulee Dam. In 1939 and 1940, a total of 3,015 adult summers, collected at Rock Island Dam from the commingled upriver stocks, were placed in upper Entiat River spawning areas. Only an estimated 1,308 of these survived to spawn (Fish and Hanavan 1948). Entiat NFH reared and released juvenile summer Chinook salmon into the Entiat River from 1941-1964 and in 1976 (Mullan 1987). Egg sources included the commingled upriver stocks intercepted at Rock Island Dam (1939-1943), Methow River (1944), Carson NFH (1944), Entiat River (1946-1964), Spring Creek NFH (1964), and Wells Dam (1974). Summer Chinook salmon spawning was monitored by aerial surveys in the lower 10.4 miles from 1957 to 1991. Positive redd identification from the air is difficult at best, therefore aerial surveys likely underestimate actual redd numbers. Spawning numbers were never high, with a maximum of 55 redds in 1967. For years 1972-1991 aerial redd counts averaged just fewer than five per year.

### **Other Species**

Bull trout presence/absence data is limited to surveys conducted in 1984 and 1987 (WDFW 1997). Since 1994, MCRFRO staff have searched for bull trout and/or redds during the spring

and summer Chinook spawning ground surveys. Between 1994 and 2003, nine redds and seven adult bull trout have been identified

Sockeye salmon are not indigenous to the Entiat River (Craig and Suomela 1941), and have only been stocked on two occasions (1943 and 1944), from Lake Quinault and Lake Whatcom stocks (Mullan 1986). A small run of sockeye salmon became established in the Entiat River and Entiat NFH collected sockeye salmon from 1944 to 1963, and their progeny were planted elsewhere (Mullan 1986). Between 1994 and 2003, a total of 204 adult sockeye have been observed by USFWS staff.

In an effort to re-introduce coho salmon to upper Columbia tributaries, the Yakama Nation has initiated a juvenile release program in the Wenatchee and Methow River Basins. Although no releases have occurred in the Entiat Basin, substantial "straying" of returning adults was documented here and elsewhere in the Upper Columbia region in 2001. No incidental sighting of coho salmon were recorded in 2003.

## METHODS

Landowners were contacted by mail to notify them of the spring and summer Chinook salmon spawning surveys and to seek permission to access their property as surveyors walked downstream.

### Spring Chinook Salmon

Methods for surveying spring Chinook salmon consists of dividing the survey area into several reaches. Single surveys of each reach were conducted twice, one in early September and again the third week of September. Each reach was surveyed walking downstream, enumerating and marking only well established redds, recording numbers of live fish and sampling any recovered carcasses. Carcasses were measured to the nearest centimeter (fork length), tails were removed to prevent recounting, gender was identified, females were dissected to visually determine spawning success, and scale samples were taken when possible. Scales were pressed onto acetate plastic and viewed using a microfiche reader to determine age and origin (wild or hatchery). Snouts were removed from carcasses with missing adipose fins for later retrieval and de-coding of coded-wire tags. All redd locations were marked with colored survey flagging on nearby vegetation to distinguish them from spring and/or summer Chinook redds in subsequent surveys, and GPS points were recorded.

Spring Chinook surveys were conducted from Fox Creek Campground to McKenzie Diversion Dam (river mile 28.1 to 16.2) from September 3-9, and September 22,-23, 2003. Mad River was surveyed on September 9, from just above Hornet Creek to just below Mad River road bridge (river mile 5.2 to 1.5) and September 24, from Pine Flats Campground to just below Mad River road bridge (river mile 3.5 to 1.5).

In 2003, the number of spring Chinook salmon spawning in the Entiat River was estimated by expanding redd counts using the estimator of 2.4 spring Chinook salmon adults per redd. In 2002, an estimator of 3.3 fish/redd was used. Explanation for this change can be found in the Discussion. In the 1994 to 2001 spawning ground reports, we also used the estimator of 2.4 fish per redd.



### Summer Chinook Salmon

Methods were same as for spring Chinook surveys with a few differences in area surveyed and timing. Surveys were conducted from Reach's 1 through 5 from October 10 to 15 and October 24 through November 6, 2003. Lower river surveys were conducted between Dinkleman Canyon Road to Fire Station (river mile 4.1 to 3.1), Fire Station to Keystone Bridge (river mile 3.1 to 1.5) and Keystone Bridge to the Columbia River influence (river mile 1.5 to 0.3) on October 28-29, and a second time on November 10. No surveys were conducted in the Mad River. The number of summer Chinook salmon that spawned was estimated by expanding redd counts using the estimator of 2.4 fish per redd.

### Other Species

Bull trout and/or redds were searched for during spring and summer Chinook salmon spawning ground surveys. Bull trout redds are generally smaller in size and utilize smaller substrate than Chinook salmon. Sockeye salmon redds were identified during the Chinook salmon surveys through observation of fish on occupied redds.

### Age Designation

Age designation in this report follows the Gilbert-Rich (1927) system, where total age is referenced by the first digit, and age at the time of migration from freshwater is indicated by the subscript.

### Estimating Coded Wire Tag expansions for Spring and Summer Chinook

Using the estimated number of spawning spring Chinook salmon (259), divided by the number of recovered carcasses (47) gives an expansion number of 5.5. To estimate the number of coded-wire tags for each tag code recovered, you would multiply the expansion number (5.5) to the number of coded-wire tags recovered in each coded-wire tag group. Note: One recovered coded-wire tag, 054517, came from a 25% adipose clipped, coded-wire tag group. Assuming carcasses were randomly recovered from the spawning grounds, the one recovered 054517 tag code, would actually account for four. Calculation methods were the same for summer Chinook salmon. The estimated number of spawning summer Chinook (742), divide by the number of recovered carcasses (106) gives an expansion number of 7.0.

## RESULTS

### Spring Chinook Salmon

Seventy spring Chinook salmon redds were counted in the old *index* area (river mile 28.1 to 21.3). An additional 38 redds were found in the expanded survey area (river mile 21.3 to 16.2), including one redd found in the Mad River. A total of **108** redds were identified during the survey (Table 1) (Figure 2). Annual redd counts from the old *index* area are found in Table 2. The peak spawning occurred around the first week in September. The total redd count of 108, included all or most of the spring Chinook salmon spawning in the Entiat River since spring Chinook are not known to spawn in the lower river. Assuming all redds were counted, the total redd count of 108, multiplied by 2.4 fish per redd, gives an estimate of **259** spring Chinook salmon adults escaping to spawn in the Entiat River. This estimate does not account for any pre-spawn mortality that may have occurred in the Entiat River.

Table 1. Spring Chinook salmon spawning ground surveys on the Entiat and Mad Rivers, 2003.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	09/03/03	23	12	5
Old <i>Index</i> Area		09/22/03	<u>2</u>	<u>1</u>	<u>1</u>
	Cumulative Total Count		25	13	6
Reach 2	25.8-23.4	09/04/03	24	8	8
Old <i>Index</i> Area		09/22/03	<u>4</u>	<u>0</u>	<u>7</u>
	Cumulative Total Count		28	8	15
Reach 3	23.4-21.3	09/09/03	15	13	9
Old <i>Index</i> Area		09/22/03	<u>2</u>	<u>4</u>	<u>4</u>
	Cumulative Total Count		17	17	13
<b>Index Total</b>			<b>70</b>	<b>38</b>	<b>34</b>
Reach 4	21.3-18.7	09/05/03	6	3	2
Expanded Area		09/22/03	<u>9</u>	<u>3</u>	<u>0</u>
	Cumulative Total Count		15	6	2
Reach 5	18.7-16.2	09/05/03	10	3	6
Expanded Area		09/23/03	<u>11</u>	<u>3</u>	<u>4</u>
	Cumulative Total Count		21	6	10
Road Mile Marker 13		09/23/03	1	0	0
Mad River	5.2-1.5	09/09/03	1	0	0
	3.5-1.5	09/24/03	<u>0</u>	<u>0</u>	<u>0</u>
	Cumulative Total Count		1	0	0
<b>Expanded &amp; Mad River Total</b>			<b>38</b>	<b>12</b>	<b>12</b>
<b>TOTAL</b>			<b>108</b>	<b>50</b>	<b>46</b>

### Spring Chinook Redd Counts

#### Reach 1 RM 28.1 to 25.8 (Old *Index* Area)

Twenty-five redds were identified in Reach 1, which accounted for 35.7% of the *index* area count and 23.1% of the total redds found in 2003.

#### Reach 2 RM 25.8 to 23.4 (Old *Index* Area)

Twenty-eight redds were identified in Reach 2, which accounted for 40.0% of the *index* area count and 25.9% of the total redds found in 2003.

#### Reach 3 RM 23.4 to 21.3 (Old *Index* Area)

Seventeen redds were identified in Reach 3, which accounted for 24.3% of the *index* area count and 15.7% of the total redds found in 2003.

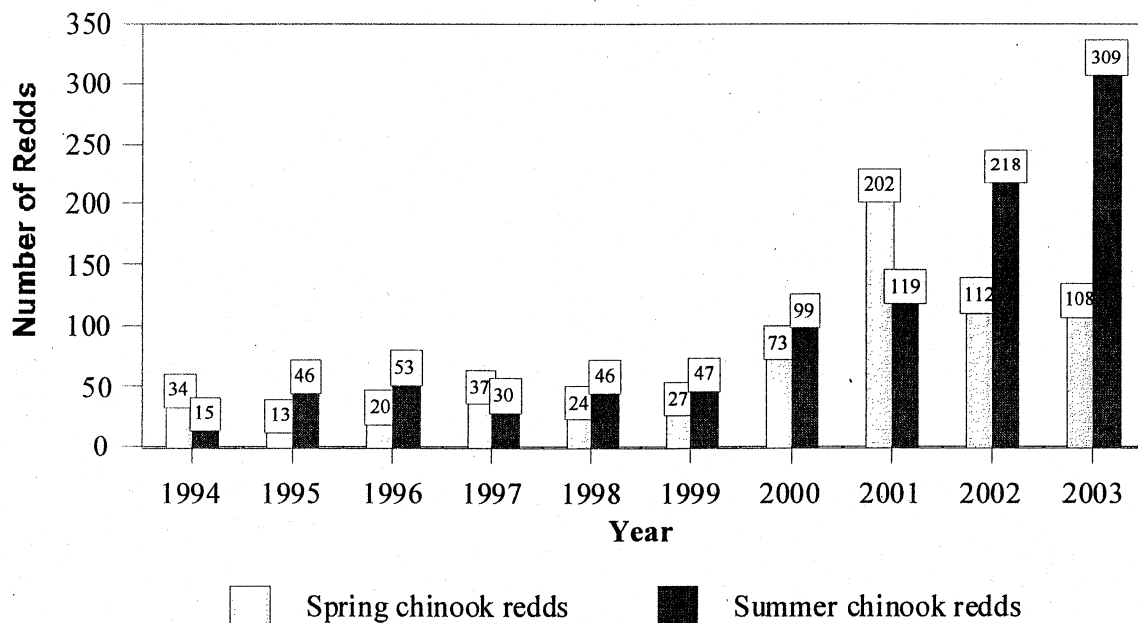


Figure 2. Total spring and summer Chinook salmon redds - Entiat River, 1994 to 2003.

Table 2. Entiat River spring Chinook salmon redd counts from annual surveys in old *index* area, Fox Creek Campground to Dill Creek (RM 28 to 21), 1962-1994 (WDFW) and 1995-2003 (USFWS).

YEAR	#of REDDS	YEAR	#of REDDS	YEAR	#of REDDS
1962	115	1976	47	1990	83
1963	145	1977	171	1991	32
1964	384	1978	326	1992	42
1965	104	1979	N/A	1993	100
1966	307	1980	107	1994	24
1967	252	1981	95	1995	1
1968	252	1982	107	1996	8
1969	83	1983	107	1997	20
1970	70	1984	84	1998	15
1971	136	1985	115	1999	6
1972	61	1986	105	2000	28
1973	229	1987	64	2001	144
1974	88	1988	67	2002	72
1975	156	1989	37	2003	70

N/A= not available

#### Reach 4 RM 21.3 to 18.7 (*Expanded Area*)

Fifteen redds were identified in Reach 4, which accounted for 13.9% of the total redds found in 2003.

Reach 5 RM 18.7-16.2 (*Expanded Area*)

Twenty-one redds were identified in Reach 5, which accounted for 19.4% of the total redds found in 2003.

Road Mile Marker 13

One redd was identified at Road Mile Marker 13, which accounted for 1.0% of the total redds found in 2003.

Mad River RM 5.2-1.5

One redd was identified in the Mad River, which accounted for 1.0% of the total redds counted in 2003.

**Spring Chinook Carcass Recoveries**

A total of 46 spring Chinook salmon carcasses were recovered from the Entiat River in 2003, of which 42 were useable. All 46 carcasses were sexed, 29 (63%) were females and 17 (37%) were males. All female carcasses were examined for spawning success. Twenty-five (86%) were completely spent, one (3%) did not spawn, and success could not be determined with three (10%) due to decomposition. No difference in spawning success between hatchery and wild females was detected. Thirty-six DNA samples were also collected from the 46 recovered carcasses.

**Spring Chinook Age Composition by Sex and Origin**

Through scale analysis and coded-wire tags, it was determined that 25 (54%) of the 46 carcasses were wild, 12 (26%) were of hatchery origin, two of which were adipose present, 4 (9%) were unidentifiable and 5 (11%) were of unknown origin, due to similar freshwater scale patterns exhibited by hatchery and wild sub-yearlings (Table 3).

Table 3. Spring Chinook salmon age composition from Entiat River carcass recoveries, 2003.

Origin	Age	Male	(N)	%	Female	(N)	%	Total	%
Hatchery	3/2		2	17		0	0	2	17
	4/1		1	8		0	0	1	8
	4/2		2	17		4	33	6	50
	5/2		<u>2</u>	<u>17</u>		<u>1</u>	<u>8</u>	<u>3</u>	<u>25</u>
			7	59		5	41	12	100
Wild	3/2		1	4		0	0	1	4
	4/2		0	0		2	8	2	8
	5/2		<u>6</u>	<u>24</u>		<u>16</u>	<u>64</u>	<u>22</u>	<u>88</u>
			7	28		18	72	25	100
*Uncertain H/W	4/1		1			4		5	
Unknown			2			2		4	
<b>Total</b>			<b>17</b>			<b>29</b>		<b>46</b>	

\* Unidentifiable origin, due to similar freshwater scale patterns exhibited by hatchery and wild sub-yearlings (John Sneva, WDFW, personal Communication). Note: Entiat NFH in May of 2000, released 421,000 sub yearlings, of these only 25% were adipose clipped/coded-wire tagged.

### Spring Chinook Coded-Wire Tag Recoveries

Ten (22%) of the 46 carcasses recovered had missing adipose fins (Table 4).

Table 4. Coded-wire tag recoveries from spring Chinook salmon carcasses, recovered in the Entiat River, 2003.

Tag code	Brood Yr.	Release Agency	Hatchery	Recovered	Estimated
054517	99	USFWS	Entiat NFH	*1	5.5
054528	99	USFWS	Entiat NFH	1	5.5
054931	98	USFWS	Winthrop NFH	1	5.5
054950	99	USFWS	Entiat NFH	1	5.5
054951	99	USFWS	Entiat NFH	2	11.0
093413	00	ODFW	Looking Glass	1	5.5
630791	00	WDFW	Chiwawa Rearing Ponds	1	5.5
631024	98	WDFW	Methow SFH	1	5.5
Ad clip/ no tag				1	0
TOTAL				10	66

\* Tag code 054517 was only 25% marked.

### Summer Chinook Salmon

A total of **309** redds were identified in 2003 (Table 5) (Figure 2). The first summer Chinook salmon redd was discovered October 15, 2003, with peak spawning occurring the second week of October. Multiplying the 309 redds by 2.4 fish per redd yields an estimate of **742** summer Chinook salmon adults escaping to spawn in Entiat River. This estimate should be considered a minimum since all portions of the lower river were not surveyed and this number doesn't account for any pre-spawn mortality.

### Summer Chinook Redd Counts

#### Reach 1 RM 28.1 to 25.8

No redds were counted in Reach 1.

#### Reach 2 RM 25.8 to 23.4

Seven redds were identified in Reach 2, which accounted for 2.3% of the total redds found in 2003.

#### Reach 3 RM 23.4 to 21.3

Six redds were identified in Reach 3, which accounted for 1.9% of the total redds found in 2003.

#### Reach 4 RM 21.3 to 18.7

Ten redds were identified in Reach 4, which accounted for 3.2% of the total redds found in 2003.

#### Reach 5 RM 18.7 to 16.2

Fifty redds were identified in Reach 5, which accounted for 16.2% of the total redds found in 2003.

#### Roaring Creek Bridge RM 6.7

Three redds were identified near Roaring Creek Bridge, which accounted for 1.0% of the total redds found in 2003.

Table 5. Summer Chinook spawning ground surveys on the Entiat River, 2003.

Section	River Mile	Date	Redds	Live Fish	Carcasses
Reach 1	28.1-25.8	10/10/03	0	1	0
Reach 2	25.8-23.4	10/15/03	5	2	0
		11/05/03	<u>2</u>	<u>1</u>	<u>0</u>
	Cumulative Total Count		7	3	0
Reach 3	23.4-21.3	10/16/03	6	2	0
		11/05/03	<u>0</u>	<u>0</u>	<u>0</u>
	Cumulative Total Count		6	2	0
Reach 4	21.3-18.7	10/16/03	9	34	1
		11/06/03	<u>1</u>	<u>4</u>	<u>0</u>
	Cumulative Total Count		10	38	1
Reach 5	18.7-16.2	10/16/03	37	54	12
		10/28/03	8	31	4
		11/06/03	<u>5</u>	<u>5</u>	<u>5</u>
	Cumulative Total Count		50	90	21
Roaring Creek Bridge	6.7	10/01/03	0	40	0
		10/17/03	3	6	0
		11/10/03	<u>0</u>	<u>0</u>	<u>1</u>
	Cumulative Total Count		3	46	1
Dinkleman Cyn. Rd. to Fire Station	4.1-3.1	10/28/03	22	29	1
		11/10/03	<u>8</u>	<u>7</u>	<u>18</u>
	Cumulative Total Count		30	36	19
Fire Station to Keystone Bridge	3.1-1.5	10/28/03	14	26	3
		11/10/03	<u>0</u>	<u>0</u>	<u>2</u>
	Cumulative Total Count		14	26	5
Keystone Bridge to Kiosk	1.5-0.4	10/28/03	68	142	9
		11/10/03	<u>22</u>	<u>7</u>	<u>31</u>
	Cumulative Total Count		90	149	40
Kiosk to Columbia R. confluence	0.4-0.3	09/17/03	0	0	4
		10/29/03	65	170	5
		11/10/03	<u>34</u>	<u>5</u>	<u>13</u>
	Cumulative Total Count		99	175	22
<b>TOTAL</b>			<b>309</b>	<b>566</b>	<b>109</b>

Dinkleman Canyon Road to Fire Station RM 4.1 to 3.1

Thirty redds were identified from Dinkleman Canyon Road to Fire Station, which accounted for 9.7% of the total redds found in 2003.

Fire Station to Keystone Bridge RM 3.1 to 1.5

Fourteen redds were identified from Fire Station to Keystone Bridge, which accounted for 4.5% of the total redds found in 2003.

Keystone Bridge to Kiosk RM 1.5 to 0.4

Ninety redds were identified from Keystone Bridge to the Kiosk, which accounted for 29.1 % of the total redds counted in 2003.

Kiosk to Columbia River Influence RM 0.4 to 0.3

Ninety-nine redds were identified from Kiosk to Columbia River Influence, which accounted for 32.1 % of the total redds counted in 2003.

**Summer Chinook Carcass Recoveries**

A total of 188 summer Chinook salmon carcasses were recovered in 2003, of which 108 were useable. Of the 108 sampled carcasses, 78 (72%) were females and 30 (28%) were males. Seventy-eight female carcasses were examined for spawning success. Thirty (38%) were completely spent, 31 (40%) did not spawn, 11 (14%) had partially spawned and 6 (8%) were not sampled due to carcass decomposition. Of the 78 useable samples, a notable difference in spawning success between hatchery and wild females was found. Only 32% of the hatchery females spawned successfully, compared to 68% of the wild females.

**Summer Chinook Age Composition by Sex and Origin**

Through scale analysis and coded wire tags, it was determined that 42 (39%) of the 108 carcasses were wild, 59 (55%) were hatchery and 7(6%) were unidentifiable (Table 6).

Table 6. Summer Chinook age composition from Entiat River carcass recoveries, 2003.

Origin	Age	Male	(N)	%	Female	(N)	%	Total (N)	%
Hatchery	3/2		3	5		0	0	3	5
	4/1		0	0		1	2	1	2
	4/2		1	2		1	2	2	4
	5/2		6	10		44	74	50	84
	6/2		0	0		3	5	5	5
			10	17		49	83	59	100
Wild	2/1		1	2		0	0	1	2
	3/2		1	2		0	0	1	2
	4/1		4	10		7	17	11	27
	4/2		2	5		1	2	3	7
	5/1		9	21		10	24	19	45
	5/2		2	5		5	12	7	17
			19	45		23	55	42	100
Unknown			1			6		7	
Grand Total			30			78		108	

**Summer Chinook Coded-Wire Tag Recoveries**

Sixty-one (58%) of the 108 identifiable carcasses recovered had missing adipose fins (Table 7).

Table 7. Coded-wire tag recoveries from summer Chinook salmon carcasses, recovered in the Entiat River, 2003.

Tag code	Brood Yr.	Release Agency	Hatchery	Recovered	Estimated
630177	99	WDFW	Turtle Rock SFH	1	7
630470	99	WDFW	Turtle Rock SFH	1	7
630475	99	WDFW	Dryden Pond	1	7
630606	97	WDFW	Turtle Rock SFH	1	7
630610	97	WDFW	Smilkameen SFH	1	7
630612	97	WDFW	Dryden	1	7
631032	98	WDFW	Turtle Rock SFH	24	168
631061	98	WDFW	Wells SFH	9	63
631148	98	WDFW	Smilkameen SFH	1	7
631151	98	WDFW	Dryden Pond	14	98
631271	00	WDFW	Dryden Pond	2	14
631272	00	WDFW	Dryden Pond	1	7
No Tags			Hatchery origin	2	14
No tags			Unknown	2	0
<b>TOTAL</b>				<b>61</b>	<b>413</b>

### Other Species

In Reaches 1-5, surveyor's observed four adult bull trout, fifteen sockeye salmon redds and five live sockeye adults. No adult coho salmon were observed.

## DISCUSSION

### Adult Escapement

From 1994 through 2001, the MCRFRO has estimated the number of spring and summer Chinook adults escaping to spawn in the Entiat River by a multiplier of 2.4 fish per redd (Kohn 1987, 1988). In 2002, a fish per redd ratio of 3.3 was calculated by combining adult and redd counts from Peshastin and Icicle Creeks. This method was an attempt to account for spring Chinook pre-spawn mortality. Inevitably, too many variables between years, water conditions between basins, and accurate adult counts, prevented us from continuing to use this method. This was also the case for utilizing historic summer Chinook redd and adult counts from the Wenatchee River. In 2003, the number of spring and summer Chinook salmon spawning in the Entiat River was estimated by expanding redd counts using the estimator of 2.4 Chinook salmon per redd.

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## REFERENCES

- Craig, J.A., and A.J. Suomela. 1941. Time of appearance of the runs of salmon and steelhead trout native to the Wenatchee, Entiat, Methow and Okanogan rivers. Unpublished MS, USFWS. 35 pp. plus 18 affidavits and accompanying letters of corroboration. *in* Mullan et. al. 1992, Appendix J.
- Fish, F.F., and M.G. Hanavan. 1948. A report on the Grand Coulee Fish Maintenance Project 1939-1947. USFWS, Special Scientific Report 55. 63 pp.
- French, R.R., and R.J. Wahle. 1960. Salmon runs - upper Columbia River, 1956-57. USFWS, Special Scientific Report 364.
- Gilbert, C.H., and W.H. Rich. 1927. Second experiment in tagging salmon in the Alaska Peninsula reservation, summer of 1923. Bull. U.S. Bur. Fish. Vol. 42: 27-75
- Kohn, M. 1987. Spring and summer chinook spawning ground surveys Methow and Okanogan River basins 1987. Yakima Indian Nation Fisheries Resource Management.
- Kohn, M. 1988. Spring and summer chinook spawning ground surveys Methow and Okanogan River basins 1988. Yakima Indian Nation Fisheries Resource Management.
- Mullan, J.W. 1986. Determinants of sockeye salmon abundance in the Columbia River, 1880s-1982: A review and synthesis. USFWS Biological Report 86(12). Leavenworth, WA. 136 pp.
- Mullan, J.W. 1987. Status and propagation of chinook salmon in the mid-Columbia River through 1985. USFWS Biological Report 89(3). Leavenworth, WA. 111 pp.
- Mullan, J.W., K.R. Williams, G. Rhodus, T.W. Hillman, J.D. McIntyre. 1992. Production and habitat of salmonids in Mid-Columbia River tributary streams. USFWS Monograph I. Leavenworth, WA. 489 pp.
- USDA. U.S. Department of Agriculture (USFS and SCS), 1979. Entiat: Cooperative River Basin Study.
- WDFW. Washington Department of Fish and Wildlife, 1997. 1997 Washington salmonid stock inventory (SaSI) bull trout and Dolly Varden. Olympia, Washington.

## PERSONAL COMMUNICATIONS

- J. Sneva, 2003. Washington Department of Fish & Wildlife.

## APPENDIX

River mile index of the Entiat River from the mouth to Entiat Falls.

River Mile	Description
0.0	Mouth of <u>Entiat River</u> at river-mile 483.7 on Columbia River
0.3	Columbia River influence
1.5	Keystone Bridge
3.1	Entiat River Road Bridge (Fire Station Restoration Site)
4.1	Dinkleman Canyon Road Bridge (Dinkleman Canyon Road Restoration Site)
6.8	Entiat National Fish Hatchery
10.1	Mad River
15.2	Potato Creek
16.2	McKenzie Ditch and Diversion Dam (end of Reach 5)
18.4	Stormy Creek
21.2	Dill Creek
23.1	Preston Creek
23.4	Brief Bridge
23.9	Brennegan Creek
25.0	McCrea Creek
25.5	Burns Creek
27.7	Fox Creek
28.0	Fox Creek Campground (start of Reach 1)
28.6	Tommy Creek
28.9	Lake Creek Campground
33.8	Entiat Falls

mileage may not be exact